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February 13, 2014

Also Sent Via E-mail

Mr. Robert J. Wyatt
NW Natural
220 N.W. Second Avenue
Portland, OR 97209

Re: Revised Hydraulic Source Control and Containment System Groundwater Model Update Report
NW Natural "Gasco Site" and Siltronic Corporation Facility
Portland, Oregon
ECSI Nos. 84 and 183

Dear Mr. Wyatt:

The Department of Environmental Quality (DEQ) reviewed the "Revised Hydraulic Source Control and Containment System Groundwater Model Update Report, NW Natural Gasco Site" dated October 2013 (Revised Model Update Report). DEQ downloaded a soft copy of the document for review on October 10, 2013. Anchor QEA, LLC (Anchor) prepared the Revised Model Update Report on behalf of NW Natural.

The Revised Model Update Report responds to DEQ's comments on the Draft Model Update Report[1] which were provided by e-mail on August 12, 2013. DEQ's August 12th comments were further discussed during a workshop on August 15, 2013 that was arranged in part to discuss the Draft Model Update Report.

The primary purpose of this letter is to inform NW Natural that the Revised Model Update Report does not address many of DEQ's previous comments and requests for information. DEQ continues to request that all aspects of model development, including the assumptions used to develop the model and the associated limitations, be fully documented. For clarification, DEQ requests that NW Natural:

- Document all hydraulic parameters selected for use in the model (e.g., horizontal and vertical hydraulic conductivity values, storage values), including tables and figures and the source(s) of the information; and
- Identify and discuss the underlying assumptions and limitations associated with all aspects of the model input parameters.

DEQ considers it important to fully document model input parameters such as hydraulic conductivity, so there are shared understandings of model construction going forward. Furthermore, identification and documentation of the assumptions used to develop the model,

[1] Anchor QEA, LLC, "Hydraulic Source Control and Containment System Groundwater Model Update Report - NW Natural Gasco Site," dated July 2013 (received via e-mail on July 29, 2013), a report prepared for NW Natural.

including the potential limitations of those assumptions, provide a basis for making future adjustments to the model.

DEQ comments on the Revised Model Update Report are attached. In addition to DEQ, the U.S. Environmental Protection Agency (EPA) reviewed the document. The DEQ and EPA comment sets are attached as Attachment 1 and Attachment 2 respectively. The attachments provide additional details regarding the information needed to complete the report.

DEQ requests that NW Natural revise and resubmit Model Update Report consistent with the attached comments on or before March 17, 2014. As soon as practicable after NW Natural receives this letter, DEQ recommends meeting to discuss the attached comments. DEQ believes a meeting will facilitate completion of the Model Update Report.

Please contact me with questions regarding this letter or the attachments.

Sincerely,

Dana Bayuk
Project Manager
Northwest Region Cleanup Section

Attachments: DEQ Comments
EPA Comments

Cc: Myron Burr, Siltronic Corporation
Patty Dost, Pearl Legal Group
Alan Gladstone, Davis Rothwell Earle and Xochihua
John Edwards, Anchor
Ben Hung, Anchor
Pradeep Mugunthan, Anchor
John Renda, Anchor
Michael Riley, Anchor
Carl Stivers, Anchor
Rob Ede, Hahn & Associates
James Peale, Maul Foster Alongi
Sean Sheldrake, EPA
Rich Muza, EPA
Lance Peterson, CDM Smith
Scott Coffey, CDM Smith
Keith Johnson, NWR/Cleanup Section
Tom Gainer, NWR/Cleanup Section
Henning Larsen, NWR/Cleanup & Tanks Section
ECSI No. 84 File
ECSI No. 183 File

ATTACHMENT 1

DEQ COMMENTS
REVISED HYDRAULIC SOURCE CONTROL AND CONTAINMENT SYSTEM GROUNDWATER MODEL UPDATE REPORT, NW NATURAL GASCO SITE
Dated October 2013 (received via download on October 10, 2013)

DEQ's comments on the above-referenced report are provided below.

Comment 1, General Comment - Model Assumptions and Limitations. DEQ previously requested NW Natural to identify the assumptions used in developing the model. DEQ acknowledges the Revised Model Update Report provides that information except as indicated below. DEQ also previously requested the limitations of each assumption on the model to be identified and discussed. DEQ considers the discussions regarding limitations provided in the revised report to be incomplete or lacking.

Examples of modeling assumptions lacking identification and/or discussions of limitations include the following:

- Designating the uplands (southwestern) side of the modal a constant head. Section 2.2.2 discusses the two constant head boundaries assigned to the model, including the Willamette River, a time-varying constant head boundary; and the southwestern boundary that corresponds approximately to the west side of Highway 30. According to Section 2.2.2, the upland constant head boundary, "...is applied over the Fill WBZ and Upper Alluvium WBZ." The revised report also indicates that, "...at the upper boundary the layers below the Upper Alluvium WBZ are modeled as inactive because the Lower Alluvium WBZ and the deep aquitard do not extend upland to Highway 30." DEQ understands from this information that for modeling purposes: 1) groundwater levels in the Fill WBZ and Upper Alluvium WBZ are the same and constant; and 2) all groundwater entering model along this boundary enters through the Upper Alluvium WBZ. Section 2.2.7 is intended to identify and discuss model assumptions and limitations associated with boundary conditions. Regarding constant head boundaries, Section 2.2.7 indicates they, "...are well defined from water level data and, therefore, do not pose any limitations." However, water levels in the Fill WBZ are typically higher than the Upper Alluvium WBZ and, as discussed further below, groundwater occurs in the basalt and likely recharges the Lower Alluvium WBZ. Consequently, DEQ considers the two assumptions to be unsupported and disagrees with the statement made in Section 2.2.7 without explanatory information.
- Designating the upstream and downstream model boundaries and the basalt as no-flow boundaries.
  - Regarding the upstream/downstream boundaries, DEQ understands the assumption is based on the general configuration of the equipotential contours (i.e., the contours are approximately perpendicular to the boundaries). However, extending the no-flow boundaries out into the river could influence the model by preventing groundwater baseflow under the river from entering and exiting the model on the upstream and downstream sides, respectively.

- As communicated by DEQ in previous correspondence, groundwater does occur in the basalt and likely recharges the alluvium. During decommissioning of cathodic protection boreholes water-bearing zones in the basalt were identified at approximately 80 feet below ground surface (bgs), and by downhole video surveys between 106 and 145 feet bgs. These zones project horizontally into the Alluvium WBZ. More recently, drilling of a test well on the Siltronic property confirmed that groundwater occurs in the basalt between approximately 80-feet and 195-beet bgs (i.e., over the approximate depth interval depicted in the model). Discharge measured from this interval during drilling was approximately 75 gallons per minute. Based on this information the revised report should further justify the assumption that the basalt is a no flow boundary and the potential limitations on the model.

- The width of the model domain decreases from the upstream to downstream boundaries. A consequence is the distance from the extraction wells to the uplands constant head boundary decreases from upstream to downstream as well. Furthermore, the downstream no flow boundary is closer to extraction wells than the upstream no flow boundary. Based on this information, it seems there is the potential for extraction wells in the downstream (northwestern) portion of the Gasco Site to interact with model boundaries during simulations. The distance between the model boundaries and the extraction wells in the northern portion of the Gasco Site is not discussed in the revised report so it is unclear whether or not it has been considered as a potential limitation.
- In general, the revised report lacks information regarding the assumptions and limitations associated with the hydraulic conductivities selected for modeling. The use of average hydraulic conductivities instead of values derived from step-testing results is not adequately explained. The hydraulic conductivity assignments to WBZs are not discussed in all cases. For example, DEQ understands the "Lower Alluvium WBZ below the Deep Aquitard" (Deep Alluvium WBZ) is assigned the average hydraulic conductivity value of the "Lower Alluvium WBZ above the Deep Aquitard" (Lower Alluvium WBZ). Based on visual observations made during drilling, the material comprising the alluvium coarsens downwards to the contact with the basalt. Consequently, the hydraulic conductivity of the Deep Alluvium WBZ is likely higher than the Lower Alluvium WBZ. Furthermore, information regarding the Fill WBZ and Upper Alluvium Silt are is included in the report. DEQ requests that the next version report include this information.
- Based on DEQ's review of figures 3 through 10, the uplands portions of the model correspond better to interpretations of the stratigraphy compared to the Draft Model Update Report. That said, geologic cross-sections C-C' and F-F' indicate that under the river appreciable thicknesses of silt occur in the alluvium that are not shown in the corresponding model sections. DEQ understands that the silt is assumed to primarily influence the vertical movement of groundwater. Consequently, the model simulates the presence of silt using vertical anisotropy. However, DEQ believes the presence of silt also influences the lateral movement of groundwater. As shown by cross-sections C-C' and F-F', silt on the channel bottom could influence lateral movement of groundwater by acting similarly to a cap. In other words the presence of silt could

restrict lateral and vertical movement of groundwater into/or out of the river. This scenario should be acknowledged and discussed in the next version of the report.

- DEQ acknowledges that the depths of observations limit interpretations of the stratigraphy beneath the river. That said, in cases where the thickness of the Upper Alluvium WBZ are projected out under the river, the thinnest interpretation is depicted. The influence of this assumption on the simulations should be discussed in the next version of the report.

The examples provided by DEQ supplement any examples provided by EPA.

Subsurface conditions beneath the Gasco Site and the Siltronic facility are complex. DEQ understands and acknowledges the need to make simplifying assumptions about the stratigraphy and hydrostratigraphy for purposes of developing the groundwater MODFLOW model. That said, DEQ believes it is important to understand the limitations of the assumptions to establish shared understandings of model construction going forward and for purposes of model documentation. Identification of the limitations associated with model assumptions will also provide a basis for making future adjustments to the model.

Comment 2, Section 2.2.1. During the geotechnical investigation of the Fill WBZ interceptor trench alignment, monitoring wells will be constructed along the property line between the Gasco and U.S. Mooring sites. DEQ requests that the data from these monitoring wells be incorporated into the model.

Comment 3, Section 2.2.4. Site-wide recharge from precipitation falling on paved and unpaved surfaces is discussed in this section of the report. Given the annual rainfall at the site, the estimated precipitation recharge rate of 10-inches/year appears low for the un-vegetated surfaces of the model. DEQ requests additional information be provided regarding the basis for the estimate. Also, recharge to the model domain from precipitation is discussed in terms of annual amounts. DEQ requests additional information on whether and how recharge rates will be incorporated into the transient model. For example, will average monthly values of infiltration rates be used in the transient model?

Comment 4, Section 2.2.6. DEQ's Section 2.2.4 comment (Comment 3) applies to transient modeling of the LNG tank basin "drain" (i.e., will transient modeling use average monthly extraction rates).

Comment 5, Section 2.4. DEQ currently understands that:

- The storage coefficients for the Fill WBZ and Upper Alluvium WBZ will be simulated using a range between 0.05 and 0.3 and values will be selected during model calibration;
- The range of storage coefficients (0.05 to 0.3) applies to the Upper Alluvium WBZ to account for situations where water levels decline below the bottom of the Upper Alluvium Silt; and

- The starting point for simulating the Lower Alluvium WBZ will be 0.0001. This value will also be selected during model calibrations.

DEQ requests that the revised version of the report confirm, clarify, or correct our understandings of how storage coefficients will be assigned and selected for the Fill WBZ and Upper Alluvium WBZ, and Lower Alluvium WBZ during the modeling process.

Comment 6, Section 2.4.2. DEQ's comments regarding this section of the Revised Model Update Report are provided below:

- DEQ's fourth bullet under Comment 1 applies here.
- The revised report indicates the average hydraulic conductivity of the Lower Alluvium WBZ between extraction wells PW-4L and PW-10L is approximately 400 feet/day. DEQ notes the average is approximately 400 feet/day excluding PW-9-92. The average including PW-9-92 is approximately 530 feet/day. The text should be reviewed and revised accordingly.
- According to the report the hydraulic conductivity of the Lower Alluvium WBZ between extraction wells PW-1L and PW-3-118 uses the values for each installation shown in Table 2. However, an average value of 180 feet/day is shown on Figure 13. The report should be reviewed and the text or figure should be revised accordingly.
- The revised report indicates that the hydraulic conductivity determined from step-testing PW-8-39 is "highly unlikely" to be representative of the Upper Alluvium WBZ in the northern portion of the site. DEQ notes PW-8-39 is completed shallower than other extraction wells. An alternative interpretation of the step-test result is that the hydraulic conductivity value is representative of the upper-most depth intervals of the Upper Alluvium WBZ in the vicinity of PW-8-39. DEQ requests that this interpretation be retained, and depending on the results of modeling be incorporated into the model.

Comment 7, Section 3.2. DEQ has numerous comments regarding this section of the revised report as follows:

- The primary model calibration parameters are identified as being the "hydraulic conductivity values in the Fill WBZ and the Upper and Lower Alluvial WBZs." Although hydraulic conductivity values for the Upper and Lower Alluvium WBZs are provided, including the basis of the values; there is no corresponding information provided for the Fill WBZ. There is also no information provided for the Upper Alluvium Silt. DEQ requests that the revised report include hydraulic conductivity values for the Fill WBZ and Upper Alluvium Silt, including tables and figures and the source(s) of the information.
- The first bullet indicates that groundwater elevation maps will be prepared for the Upper and Lower Alluvium WBZs. DEQ requests that water elevation contour maps be prepared for the Fill WBZ for completeness and for comparison.
- DEQ requests that the time intervals referenced in the 2nd bullet be specified and the rational for the selection(s) be provided.
- For purposes of documenting the results of modeling, DEQ requests that the model's water budget (i.e., inflows and outflows) be presented for each WBZ. DEQ further

requests that flows simulated by the calibrated model be compared to the "current model."

- DEQ requests clarification on whether the lines of evidence used for calibration of the transient model will be qualitatively judged, or whether specific numerical targets or criteria will be used. If it is premature to specify site-specific calibration criteria, DEQ requests that typical values (or ranges of values) be provided to serve as the initial modeling goals.

Comment 8, Reporting. The Revised Model Update Report does not indicate that reports will be prepared to document the modeling process. DEQ requests that an additional section (Section 3.4, Reporting) be added to the report to identify steps in the modeling process where reports will be prepared for DEQ's information and/or review and approval. At a minimum, DEQ requests that NW Natural submit a report documenting calibration of the model to the set-point data sets. In addition, DEQ requests that NW Natural provide routine written updates on the modeling process. DEQ further requests that the updates be provided for discussion during monthly meetings with the purpose of documenting adjustments being made to the model. Furthermore, consistent with our September 22, 2011 letter commenting on the Revised Interim Design Report[1], DEQ again requests NW Natural to provide the current working version of the model for our information and use. NW Natural agreed to this request in the November 4, 2011 letter responding to DEQ's comments. DEQ will anticipate receiving a copy of the current working version of the model on or before February 27, 2014. DEQ also requests that NW Natural provide updated working versions of the model after they are approved for use in the next phase of modeling.

[1] Anchor QEA, LLC, 2011, "Draft Groundwater Source Control Final Design Report, NW Natural Gasco Site" dated May 2011 (received May 9, 2011), a report prepared on behalf of NW Natural.

ATTACHMENT 2

COMMENTS ON REVISED HYDRAULIC SOURCE CONTROL AND CONTAINMENT SYSTEM MODEL UPDATE REPORT, NW NATURAL GASCO SITE DATED OCTOBER 2013

The following are U.S. Environmental Protection Agency comments on the document titled *Revised Hydraulic Source Control and Containment System Groundwater Model Update Report, NW Natural Gasco Site* dated October 2013 prepared by Anchor QEA, LLC for NW Natural.

Comment 1, Page ii, Table of Contents. The Table of Contents section is missing references to the two appendices attached to the revised report. NW Natural should add these to the Table of Contents.

Comment 2, Page 6, Section 2.1, third sentence. The last part of this sentence that states "...across the navigation channel to the northeast" appears to be a relic of earlier proposals to draw the model boundary across the navigation channel and merge with a City of Portland numerical model. NW natural should delete or re-word this part of the sentence to clarify that the model boundary does not extend across the navigation channel.

Comment 3, Page 13, Section 2.2.7. The narrative of this section is missing explanations and documentation of the impacts/biases from these model assumptions. The section points out assumptions and proceeds to explain how they will be evaluated and addressed, but it does not provide the reader any understanding of what effect these assumptions have to the model. NW Natural needs to include further elaboration in the narrative. For example, the first assumption presented in the section describes no-flow boundary assumptions for the upstream and downstream model boundaries. The document should then explain what this assumption may do to modeled heads and their response to pumping, such as potentially increasing drawdown response to the pumping wells (over-predicting hydraulic control and containment (HC&C) system response), since no-flow boundaries prevent additional water into the model. Conversely, no-flow boundaries will also prevent water flowing out of the model (discharge). This potential lack of discharge could present higher heads and a lower than observed drawdown (under-predicted) response to HC&C pumping. This is one example of assumptions presented in this section that require further development concerning potential impacts/biases. NW Natural should enhance the narrative in this section, or create a table that clearly documents the potential impacts/biases for each model assumption.

Comment 4, Pages 16-17, Sections 2.4.2 and 2.4.2.1. Similar to the comment 3 above, the assumptions made for averaging hydraulic conductivity and not using the lower, or higher hydraulic conductivities determined at each well (e.g. 2 ft/day at PW-8-39) imparts an effect to the model that may, or may not be reality.

This effect needs to be explained and this explanation is absent in the narrative. NW Natural should enhance the last section to describe what the model would under-predict/over-predict in

terms of modeled head response to the HC&C system if the assumed average hydraulic conductivity in the model in reality was too high or too low.